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DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

1290-US

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

10/019589

INTERNATIONAL APPLICATION NO.
PCT/GB00/02492INTERNATIONAL FILING DATE
23 June 2000PRIORITY DATE CLAIMED
23 June 1999

TITLE OF INVENTION

QUALIFYING TELEPHONE LINES FOR DATA TRANSMISSION

APPLICANT(S) FOR DO/EO/US **FAULKNER, Roger**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☐ Other items or information:

U.S. APPLICATION NO. 10/019589 <small>(If known, see 37 CFR 1.53)</small>		INTERNATIONAL APPLICATION NO. PCT/GB00/02492		ATTORNEY'S DOCKET NUMBER 1290-PCT	
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21. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO. \$1040.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY	
				\$ 890.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$	
Total claims	37 - 20 =	17	x \$18.00	\$ 306.00	
Independent claims	5 - 3 =	2	x \$84.00	\$ 168.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$280.00	\$	
TOTAL OF ABOVE CALCULATIONS =				\$	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$	
SUBTOTAL =				\$ 1364.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$ 40.00	
TOTAL FEES ENCLOSED =				\$ 1404.00	
				Amount to be refunded: \$	
				charged: \$	

a. ☐ A check in the amount of \$ _____ to cover the above fees is enclosed.

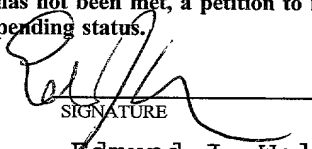
b. ☒ Please charge my Deposit Account No. 20-0515 in the amount of \$1404.00 to cover the above fees.
 A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any
 overpayment to Deposit Account No. 20-0515. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card
 information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR
 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.**

SEND ALL CORRESPONDENCE TO:


 SIGNATURE
Edmund J. Walsh
 NAME
32950
 REGISTRATION NUMBER

QUALIFYING TELEPHONE LINES FOR DATA TRANSMISSIONBackground of the Invention

5 This invention relates generally to telephone lines, and more particularly, to qualifying telephone lines for data communications.

Public switched telephone networks, e.g., plain old telephone systems (POTS), were originally designed for voice
10 communications having a limited frequency range. Today, the same POTS networks often carry data transmissions using higher frequencies. The difference in frequencies suggests that some POTS lines, which function well for voice, will function poorly for data. The risk of poor quality data
15 transmissions has motivated telephone operating companies (TELCO's) to develop tests for predicting the quality of lines for data transmissions.

One quality test uses physical line length to determine a line's attenuation. The attenuation of a line
20 whose length is less than about four kilometers (km) is usually low enough for data transmission. But, measuring the line length is typically more involved than measuring the straight line distance between a customer's address and a switching station. Typically, lines form branching
25 structures rather than going radially from the switching station to the customer addresses. Thus, determining a line length usually entails manually mapping the actual branching structures connecting the customer to the switching station. Such complex manual techniques can be time intensive and may
30 lead to errors.

Furthermore, determining that a line's length is less than a preselected limit, e.g., four km, may be insufficient to qualify the line for data transmission. The line's attenuation also depends on the physical properties
35 of each branch segment making up the line, e.g., the gauge mixture of the line. In lines having segments with

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different properties, the above-described mapping technique generally should take into account the properties of each segment to determine the total attenuation of the line.

TELCO's have also used direct electrical tests to determine the quality of POTS lines for data transmissions. Typically, such tests are manual and two-ended. Two-ended tests involve sending one employee to a customer's address or final distribution point and another employee to a switching station. The two employees coordinate their activities to perform direct electrical measurements on the customer line using hand-held devices. These two-ended measurements are substantially independent of the termination characteristics at the customer's address. An example of two-ended measurements is described in ROEHRKASTEN W: 'MESSUNG VON XDSL-PARAMETERN' NACHRICHTENTECNIK ELEKTRONIK, DE, VEB VERLAG TECHNIK. BERLIN, vol. 48, no. 2, 1 March 1998 (1998-03-01), pages 20-21, XP000752845 ISSN: 0323-4657.

Nevertheless, these two-ended tests need two separate employees, which makes them labour intensive. The labour requirements affect the cost of such tests. The two-ended tests cost about \$150 per customer line. This cost is so high that a TELCO is often prohibited from using such tests for all customer lines.

HEDLUND, ERIC; CULLINAN, TOM: 'DSL Loop Test' TELEPHONY, vol. 235, no. 8, 24 August 1998 (1998-08-24), pages 48 -52, XP002147002 USA, mentions single-ended testing but does not specify how such testing may be performed.

The present invention is directed to overcoming, or at least reducing, one or more of the problems set forth above.

Summary of the Invention

In a first aspect, the invention provides a method of assessing the suitability of customer telephone lines for data transmission. The method includes selecting a telephone line via a test access of a switching station and electrically connecting the tip and ring wires adjacent one end of the selected line in a common mode configuration. The method also includes performing single-ended electrical measurements on the tip and ring wires with respect to ground by driving the tip and ring wires in the common mode.

The method includes determining an electrical property of the wires from the single-ended measurements.

In a second aspect, the invention provides a system for determining a signal attenuation of a customer line.

5 Each customer line has tip and ring wires. The system includes a measurement unit having first and second input terminals to couple to a test access of a telephony switch. The measurement unit is capable of driving the input terminals in a common mode configuration with respect to
10 ground to perform single-ended impedance measurements on the tip and ring wires of the customer lines in the common mode configuration.

In a third aspect, the invention provides a method of marketing customer telephone lines for selected data
15 transmission services. Each line has associated tip and ring wires. The method includes automatically performing single-ended electrical measurements on the customer telephone lines and determining which of the customer lines qualify for a selected data transmission service from the
20 measurements. The tip and ring wires are driven in a common mode configuration during at least a portion of the measurements upon the associated lines. The method includes sorting the lines by distribution point and qualification to transmit data. The method also includes offering the
25 selected data service to a portion of the customers in response to lines determined to be qualified for the service being available.

Brief Description of the Drawings

30 Other objects, features, and advantages of the invention will be apparent from the following description, taken together with the drawings in which:

FIG. 1 shows an embodiment of a system for testing the suitability of customer lines for data transmission;

FIG. 2 shows the segments of one customer line from FIG. 1;

5 FIG. 3 is a flow chart illustrating a method of testing telephone lines for data transmission;

FIG. 4 shows a portion of the measurement unit that performs impedance measurements on the lines of FIG. 1;

10 FIG. 5 is a flow chart for a method of qualifying customer lines using low frequency measurements on tip and ring wires driven in a common mode configuration with respect to ground;

FIG. 6 is a table comparing attenuations found with the methods of FIG. 5 to reference values; and

15 FIG. 7 is a flow chart illustrating a method of marketing data transmission services for customer lines.

Description of the Preferred Embodiments

20 FIG. 1 shows a portion of a POTS network 8. The network 8 includes customer lines 12-14 connecting customer units 16-18, i.e., telephones and/or modems, to a telephony switch 15 located in a TELCO central office 10. The switch 15 may be a POTS switch or any other device for connecting the lines 12-14 to the telephone network 8, e.g., a digital subscriber loop access multiplexer (DSLAM) (not shown).

25 Each customer line 12-14 is a twisted copper two-wire pair adapted for telephone voice communications. The two wires of each line 12-14 are generally referred to as the ring and tip wires. The lines 12-14 are contained in one or in a series of standard telephony cables 20. The
30 cable 20 may carry more than a dozen customer lines (not all shown) thereby creating an environment that changes electrical and transmission properties of the separate lines

12-14. The properties of the lines 12-14 may also depend on their segment structure.

FIG. 2 shows that the customer line 12 has several paired copper two-wire segments 21-23. The segments 21-23 are located in separate cables 20, 24-25 and couple serially through couplers 26. Each segment 21-23 may have a different length and/or gauge than the other segments 21-23. The segmented structure of the line 12 can affect electrical properties, e.g., the signal attenuation.

Referring again to FIG. 1, single-ended measurements on the lines 12-14 are performed with a measurement unit 27 located in the central office 10. The measurement unit 27 couples, via a line 28, to a standard voice test access 29 of the switch 15. The test access 29 provides electrical couplings to selected customer lines 12-14 in a voice frequency range of at least between 300 Hertz (Hz) and 4 kilo-Hz (KHz), i.e., a low frequency range. The measurement unit 27 uses the test access 29 to perform a single-ended measurements on the lines 12-14, e.g., impedance measurements.

The line testing is controlled by a computer 30. The computer 30 sends signals the switch 15, via line 31, e.g., to select the line 12-14 to be tested. The computer 30 sends signals to the measurement unit 27, via line 32, to select and control the test to be performed. The measurement unit 27 sends measurement results to the computer 30 via the same line 32.

The computer 30 includes a storage medium 33 encoding an executable software program for testing selected ones of the lines 12-14. The program includes instructions for one or more methods of controlling single-ended measurements on the lines 12-14. The program also includes instructions for methods of analyzing the measurements to

qualify or disqualify the lines 12-14 for data transmissions. Both types of method are described below.

The line testing qualifies or disqualifies the individual lines 12-14 being tested. To qualify, the computer 30 must predict that the line 12-14, under test, will support data transmissions without remedial measures. To disqualify, the computer 30 must predict that the line 12-14, under test, will not support data transmissions without remedial measures. The computer 30 may perform tests before or after the line 12-14, under test, is in service for data transmissions.

Tests to qualify or disqualify a line 12-14 for data transmission involve several steps. For each step, the computer 30 signals the switch 15 to disconnect the particular line 12-14, selected for testing, from the line card (not shown) and reroute the line to the test access 29. When the switch 15 reroutes the line, the computer 30 signals the measurement unit 27 to perform preselected single-ended measurements on the selected line 12-14. The measurement unit 27 performs the measurements and returns results to the computer 30. After receiving the results of the measurements, the computer 30 signals the switch 15 to reroute the selected line 12-14 to the line card. Then, the switch 15 transfers connections for the selected line 12-14 to the line card enabling the associated customer unit 16-18 to again communicate with the rest of the network 8.

FIG. 3 is a flow chart illustrating a method 50 for determining the suitability of a selected one of the customer lines 12-14 for a preselected data transmission service. By way of example, the line 12 of FIG. 1 is selected, but any of the lines 12-14 can be evaluated by the method 50. Each step of the method 50 includes one or more single-ended measurements on the selected line 12 and an

analysis of the measurements by the computer 30 as has been already described. In addition, the steps of the method 50 fall into two stages.

In the first stage, the computer 30 tests for
5 traditional line faults by performing independent electrical measurements on the tip and ring wires T, R of the selected line 12. First, the computer 30 performs such measurements to determine whether the selected line 12 has any metallic faults (step 52). Metallic faults include shorts to ground,
10 to a voltage source, or between the paired wires T, R, and/or capacitive imbalances between the paired wires T, R of the selected line 12. Second, the computer 30 performs such measurements to determine whether the selected line 12 has any speed inhibiting faults (step 54). Speed inhibiting
15 faults include resistive imbalances between the paired wires T, R of the selected line 12, and split pair or load inductances. Speed inhibiting faults also include bridged taps that reflect signals resonantly, e.g., the spurious tap 55 shown in FIG. 2, and elevated line-noise levels.

20 The threshold values of single-ended measurements, which indicate the above-described faults, generally depend on the type of data transmissions. Methods for performing and analyzing such single-ended measurements are known in the art. For example, U.S. Application No. 60/106,845
25 ('845), filed November 3, 1998, by Roger Faulkner et al, and U.S. Patents 5,699,402 ('402) and 4,113,998 ('998) describe such methods and apparatus. The '845 application and '402 and '998 patents are incorporated by reference, in their entirety, in the present application. The '402 application
30 and the '402 and '998 patents also describe apparatus 53, of the measurement unit 27 used for the single-ended measurements to detect the faults.

If the computer 30 finds either a metallic or a speed-inhibiting fault, the computer 30 disqualifies the selected line 12 for data transmissions (block 56). If the computer 30 finds no such faults, the computer 30 determines whether the selected line 12 attenuates signals of a selected frequency by more than a threshold value for the preselected data transmission service (step 58). In the absence of faults, the signal attenuation at high frequencies is the primary measure for determining a line's ability to transmit data.

FIG. 4 shows portions of the measurement unit 27 for measuring the impedances subsequently used to determine the attenuation of the selected customer line 12. The measurement unit 27 includes an AC signal generator 36, which provides an AC driving voltage and current for measuring the impedances. During the measurements, the AC signal generator 36 drives two input terminals 40, 41 in a common mode configuration. The input terminals 40, 41 electrically connect internally at a point 43 to produce the common mode configuration. The terminals 40, 41 also couple, via the line 28, to the test access 29 of the switch 15. The measurement unit 27 also has a voltmeter 38 to measure the driving voltage with respect to ground, and an ammeter 40 to measure the driving current in the common mode configuration.

The test access 29 has internal connections 44, which electrically couple the tip and ring wires T, R of the line 12 under test to the terminal 40 and the terminal 41, respectively. Thus, the tip and ring wires T, R are electrically connected together, at the switch end, so that the signal generator 36 drives these wires T, R in common mode configuration during impedance measurements. Driving the wires T, R in common mode makes electrical measurements

insensitive to termination characteristics of the customer unit 16.

Both the preselected threshold value for the signal attenuation and the preselected frequency depend on the type of data transmission. For ISDN data transmissions, the preselected threshold is about 45 deci-Bells (dB) at 100 KHz. For ASDL data transmissions, the preselected threshold is about 40 dB at 300 KHz depending on deployed terminal equipment.

If the signal attenuation at the preselected frequency is above threshold, the computer 30 disqualifies the selected line 12 for the corresponding type of data transmissions (block 56). If the signal attenuation is below threshold at the preselected frequency, the computer 30 qualifies the line 12 for the corresponding type of data transmissions (block 60) providing no faults were found at either step 52 or step 54.

FIG. 5 illustrates one method 70 of determining whether the signal attenuation for the selected line 12 is above the threshold in step 58 of FIG. 4. First, the measurement unit 27 performs single-ended common-mode measurements of the capacitance C and the impedance Z of the selected line 12 as described with relation to FIG. 3 (step 72). The measurements of C and Z are typically low frequency measurements, i.e., between about 300 Hz to 4 KHz, because the standard test access 29 of the switch 15 does not necessarily support high frequency measurements. If the test access 29 supports higher frequency measurements, such frequencies can be used to set a better resolution on the high frequency attenuation of the selected line 12.

The measurement unit 27 measures the capacitance C and then uses the value of C to determine the frequency for measuring the impedance Z . The capacitance C is a lumped

value between the common mode tip and ring wires T, R and ground. The measurement unit 27 determines C at a low frequency, e.g., 80 Hertz (Hz). If the measured value of C is less than 400 nano-Farads (nF), the AC signal generator 5 27 drives the tip and ring wires T, R in common-mode at about 2.5 KHz to measure the impedance Z. If the value of C is greater than 400 nF, the AC signal generator 27 drives the tip and ring wires T, R, in common-mode, at a higher frequency between about 3 and 20 KHz, e.g., 3.0 KHz, to 10 measure the impedance Z. The computer 30 uses the relation $Z = V/I$, where the voltage V is measured by the voltmeter 38 and the current I is measured by the ammeter 40, to find Z.

Next, the computer 30 determines the signal attenuation A(f) at high frequencies characteristic of data 15 transmissions using the low frequency measurements of C and Z (step 74). The high frequencies are more than ten times the frequencies used for measuring Z and C. The value of "A(f)" at higher frequency "f" is known from an empirical formula (1) given by:

$$A(f) = K[Z^2 + (2\pi fC)^{-2}]^{-1/2}. \quad (1)$$

The value of K = 5,000 dB-ohms provides good predictions of the attenuation A(f), in dB, for C and Z (in ohms) measured at low frequencies as described above. For this value of K, the frequency f, at which the attenuation is to be 25 determined, should be between about 40 KHz and 300 KHz.

Next, the computer 30 determines whether the high frequency attenuation A(f) is above the preselected threshold for the selected type of data transmissions (step 76). If the attenuation A(f) is above the threshold, the 30 computer 30 disqualifies the selected line 12. If the attenuation is below threshold, the computer 30 qualifies the selected line for the selected data transmissions.

FIG. 6 shows a table 80 comparing values of the signal attenuation A, in dB, at high frequencies, found using the method 70, to reference values, found by an independent method, i.e., simulators. Column 3 of table 80 shows the values of A(f) predicted from low frequency measurements of C and Z and the formula (1). Column 4 of table 80 shows the values of A(f) obtained from simulators of customer lines, i.e., the reference values. The values of attenuation A(f) of FIG. 6 are given in dB's at a frequency "f" of about 100 K Hz.

The values of the high frequency attenuation A(f) of the table 80 correspond to a variety of one and two segment structures for the selected customer line 12. Columns 1 and 2 list segment lengths and gauges, i.e., diameters in millimeters, for the copper tip and ring wires T, R of the selected line 12. For each one and two segment structure shown, the predicted and reference attenuations differ by less than about 2 dB. Generally, formula (1) gives values of the high frequency attenuation A, which differ by less than about 3 dB for various segment mixtures if the wire gauges are between about .4 mm and .7 mm and total line lengths are less than about 6.5 km.

FIG. 7 is a flow chart illustrating a method 90 of marketing preselected data transmission services for the customer lines 12-14 of FIG. 1. First, a TELCO performs common-mode single-ended electrical measurements on the selected group of lines 12-14 as described in relation to FIG. 3 and step 70 of FIG. 5 (step 92). Next, the TELCO determines which of the lines 12-14 qualify for the preselected data service from the measurements (step 94). This determination includes performing the steps 74 and 72 of the method 70 of FIG. 5 and may include the steps 52 and 54 of the method 50 of FIG. 4. The determination includes

sorting the lines based on their final distribution points and qualification status for the preselected data transmission service. Next, the TELCO offers the preselected data transmission service to the portion of the customers to which the lines 12-14 qualified in step 94 are available, i.e., customers at final distribution points with qualified lines (step 96). The TELCO connects a portion of the qualified lines 12-14 to the customers who subsequently request the offered data services (step 98). The TELCO also bills usage for a portion of the lines 12-14 at prices that depend on whether the lines 12-14 qualify or disqualify for the data transmission services (step 100).

To provide the requested data services at step 98, the TELCO may swap customer lines to the same final distribution point. The swapping reassigns a qualified line to a customer requesting data service if the customer's own line is disqualified. The swap reassigns the customer's original disqualified line to another customer, who is at the same final distribution point and not demanding data service. The disqualified line can still provide voice services to the other customer. Thus, swapping can increase a TELCO's revenue by making more lines available for more expensive data services.

A TELCO can also use swapping in response to a request by the customer for data services. In response to such a request, the TELCO determines whether the customer's own line qualifies for the requested service by the above-described methods. If the line qualifies, the TELCO provides the customer data services over his own line. If the line disqualifies for the requested service, the TELCO performs additional qualification tests on other lines to the same final distribution point, which are not presently used for data transmission services. If one of those lines

qualifies for the requested data service, the TELCO swaps the customer's line with the qualified line. Then, the qualified line provides data services to the customer requesting such services and the unqualified line provides

5 normal voice service to the other customer.

Other embodiments are within the scope of the following claims.

What is claimed is:

1. A method of assessing the suitability of customer telephone lines for data transmission, comprising:
selecting a telephone line having tip and ring wires via a test access of a switching station;
5 electrically connecting the tip and ring wires together adjacent one end of the selected line to form a common mode configuration;
performing single-ended electrical measurements by driving the wires in the common mode configuration with
10 respect to ground; and
determining an electrical property of the wires from the single ended measurements.

2. The method of claim 1, wherein the determining comprises finding an impedance (Z) of the wires in the
15 common mode configuration.

3. The method of claim 2, wherein the performing comprises driving the wires at low frequencies and the act of the determining finds a property at a high frequency, the high frequency being at least ten times the highest one of
20 the low frequencies.

4. The method of claim 2, wherein the determining comprises calculating an attenuation from the impedance.

5. The method of claim 4, wherein the measuring comprises finding a capacitance (C) for the tip and ring
25 wires in the common mode configuration.

6. The method of claim 5, wherein the calculating uses a formula to obtain the attenuation (A(f)), the formula

being $A(f) = K[Z^2 + (2\pi fC)^{-2}]^{-1/2}$, the f being the frequency, and the K being a number.

7. The method of claim 2, further comprising:
determining whether the selected line has a line
5 fault; and
disqualifying the line in response to finding the
line fault.

8. The method of claim 2, wherein the fault is a
speed inhibiting fault.

9. The method of claim 8, wherein the speed
10 inhibiting fault includes one of a resistance imbalance, a
bridged tap, a load coil, and a noise level above a
preselected threshold.

10. The method of claim 8, wherein the line fault
15 includes a metallic fault.

11. The method of claim 10, wherein the metallic
fault includes one of a capacitance imbalance, a short to
ground, a short to a voltage source, and an intermediate
short between the tip and ring wires.

12. The method of claim 10, further comprising:
20 determining whether the selected line has a speed
inhibiting fault; and
disqualifying the line in response to finding the
speed inhibiting fault.

13. The method of claim 8, wherein the act of determining an electrical property includes calculating an attenuation for the line using the electrical measurements.

14. A system for determining signal attenuations of customer telephone lines, each line having tip and ring wires, comprising:

a measurement unit having first and second input terminals to couple to a test access of a telephony switch, the measurement unit capable of driving the input terminals in a common mode configuration to perform single-ended impedance measurements on the tip and ring wires of the customer lines.

15. The system of claim 14, wherein the measurement unit further comprises:

a voltmeter coupled to measure a voltage driving said input terminals in the common mode configuration; and
an ammeter coupled to measure a current going to said input terminals in the common mode configuration.

16. The system of claim 15, wherein the measurement unit further comprises:

a signal generator connected to the first and second terminals to drive said terminals in the common mode configuration.

17. The system of claim 15, wherein the measurement unit further comprises apparatus to perform single-ended measurements to detect one of metallic faults and speed inhibiting faults on the customer lines.

18. The system of claim 14, further comprising:

a processor coupled to the measurement unit and capable of coupling to the switch, the processor having a data storage medium encoding a program of instructions for a method, the method comprising:

5 ordering the measurement unit to perform the single-ended measurements; and

analyzing results of the ordered measurements to determine a signal attenuation of the one of the customer lines.

10 19. The system of claim 18, wherein the method further comprises:

determining whether the one of the lines is qualified to transmit data from the signal attenuation.

15 20. The system of claim 18, wherein the signal attenuation corresponds to a frequency at least ten times frequencies at which the measurement unit is capable of driving the one of the lines through the test access.

20 21. The system of claim 18, wherein the method further comprises:

ordering the switch to transfer connections for the one of the lines from the network to the test access prior to the act of ordering the measurement unit.

25 22. The system of claim 14, further comprising:
the switch having the test access, the switch being
a central office switch.

23. The system of claim 17, wherein the test access is adapted to transmit electrical signals having voice-range frequencies.

24. A program storage device encoding an executable program of instructions for a method of determining the signal attenuation of customer telephone lines connected to a central switch, the method comprising:

5 ordering the switch to transfer connections for one of the lines from the network to a test access of the switch;

10 ordering a measurement unit to perform single-ended impedance measurements on tip and ring wires of one of the lines by driving the tip and ring wires in a common mode configuration using the test access; and

 analyzing results of the ordered measurements to determine a signal attenuation of the one of the customer lines.

15 25. The device of claim 24, wherein the method further comprises:

 determining whether the one of the lines is qualified to transmit data from the signal attenuation.

20 26. The device of claim 24, wherein the signal attenuation corresponds to a frequency (f) at least ten times signal frequencies of the single-ended measurements.

 27. The device of claim 26, wherein the act of analyzing comprises:

25 calculating the attenuation (A) based on a formula, the formula being $A(f) = K[Z^2 + (2\pi fC)^{-2}]^{-1/2}$, and

 wherein Z and C are the respective impedance and capacitance of the line in the common mode configuration.

 28. The device of claim 24, the method further comprising:

determining whether the selected line has a line fault; and

disqualifying the line in response to determining that the line has a fault.

5 29. A method of marketing customer telephone lines for a selected data transmission service, each line having associated tip and ring wires, comprising:

10 automatically performing single-ended electrical measurements on a selected plurality of customer telephone lines while the associated tip and ring wires are connected together in a common mode configuration;

 determining which of the customer lines qualify for the selected data service from the measurements;

15 sorting the lines based on final distribution points and qualification for the data service; and

 offering the selected data service to a portion of the customers in response to said portion having qualified lines available.

20 30. The method of claim 29, further comprising:

 billing customers for usage of the lines at rates depending on whether the lines qualified for the selected data transmission service.

25 31. The method of claim 29, wherein the act of determining includes finding a signal attenuation of the lines and qualifying lines having signal attenuations below a preselected threshold.

 32. The method of claim 31, further comprising:
 monitoring a second portion of the customer lines after being placed in service by

repeatedly performing one-ended common-modes
electrical measurements on the second portion; and
determining which of the lines of the second portion
are qualified for the selected data transmission service
5 from the repeated measurements.

33. The method of claim 29, further comprising:
providing the data transmission service for a second
portion of the lines qualified for the selected data
transmission service in response to receiving requests from
10 the associated customers for the service.

34. A method of marketing data transmission
services to customers over telephone lines having associated
tip and ring wires, comprising:

performing single-ended electrical tests on a
15 plurality of telephone lines connected to a final
distribution near where a customer is located, the tests
driving tip and ring wires of the lines under test in a
common mode configuration;

determining whether the tested lines qualify for a
20 selected data service; and

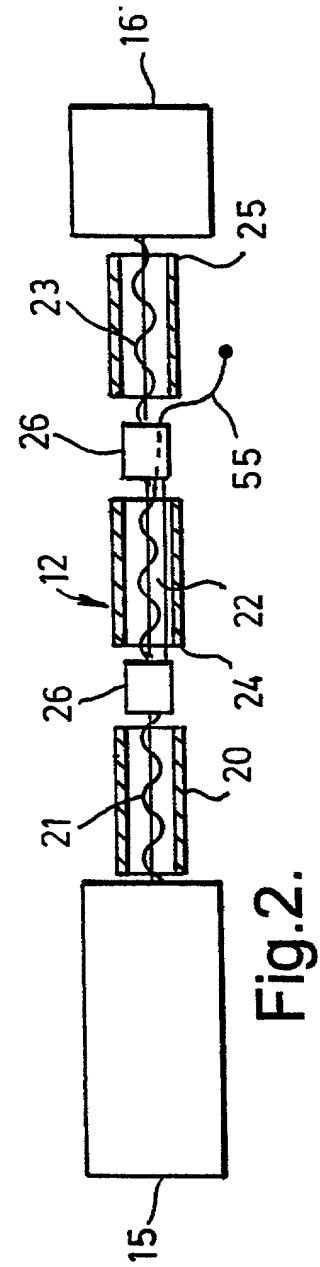
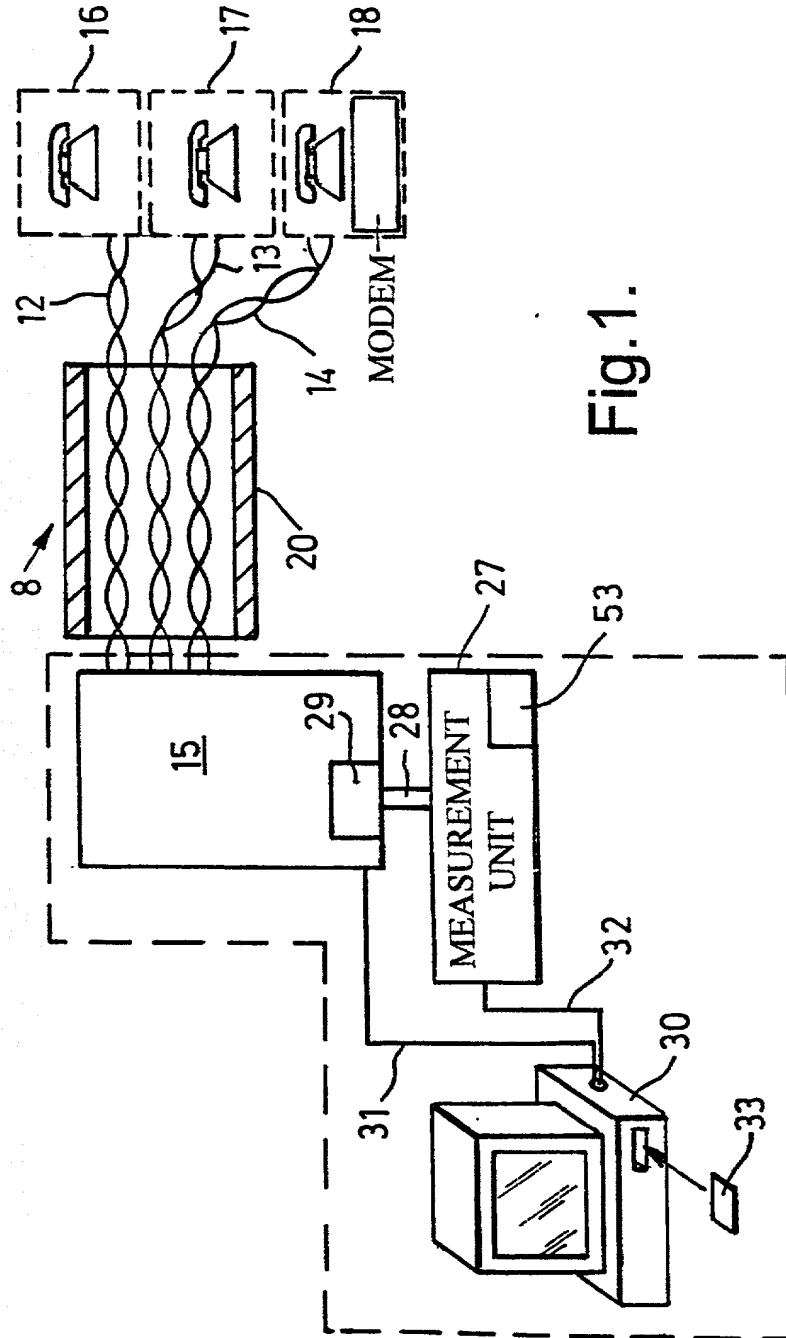
offering the data service to the customer over one
of the tested lines in response to the one of the tested
lines being qualified.

35. The method of claim 34, further comprising:
25 swapping the one of the tested lines with a line
originally used by the customer in response to the line
originally used by the customer being disqualified for the
data service.

36. The method of claim 35, wherein the act of determining includes finding a signal attenuation of the tested lines and qualifying the tested lines having signal attenuations below a preselected threshold.

5 37. The method of claim 34, wherein the act of performing tests is responsive to receiving a request from the customer for the selected data service.

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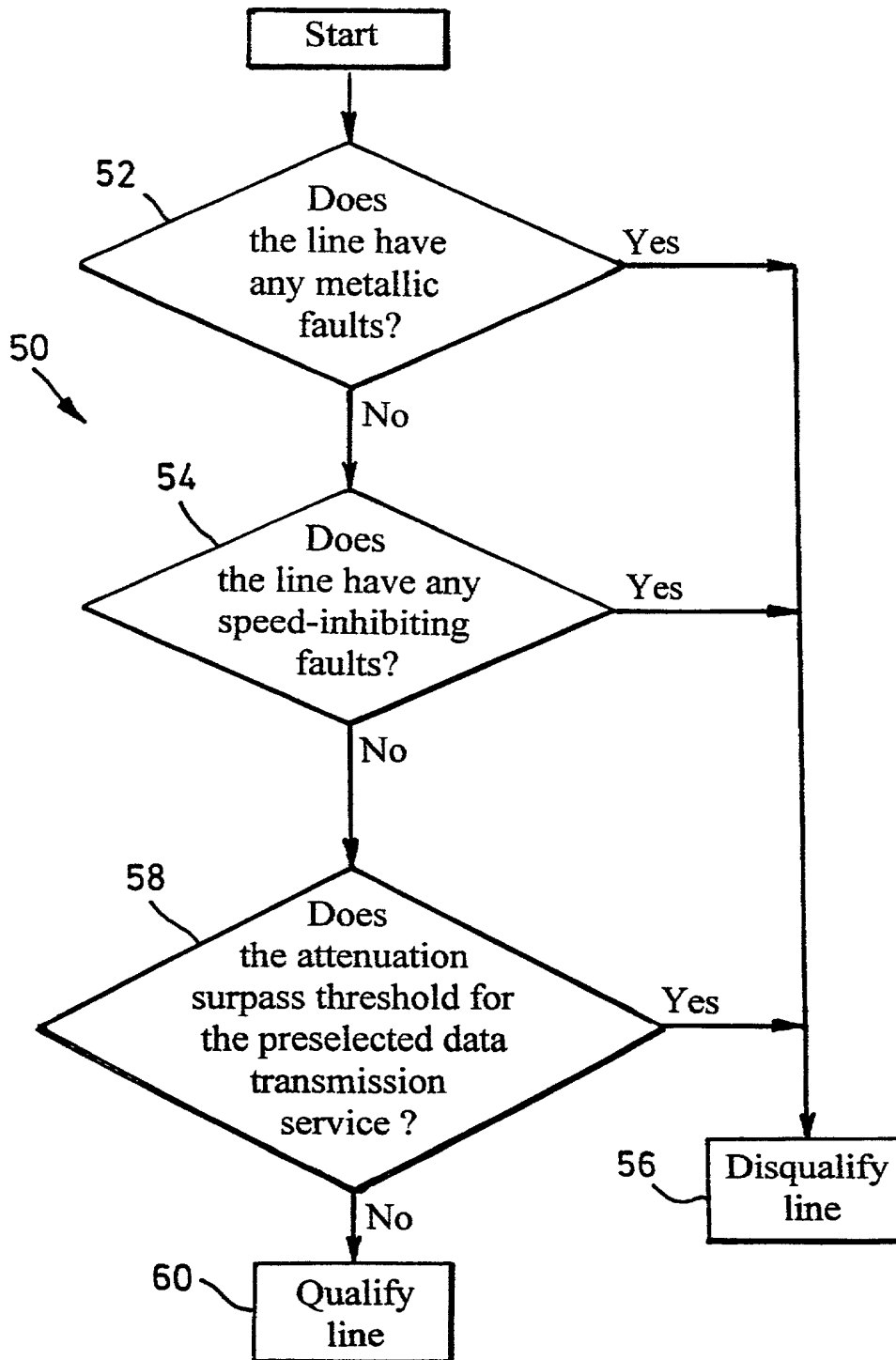


Fig.3.

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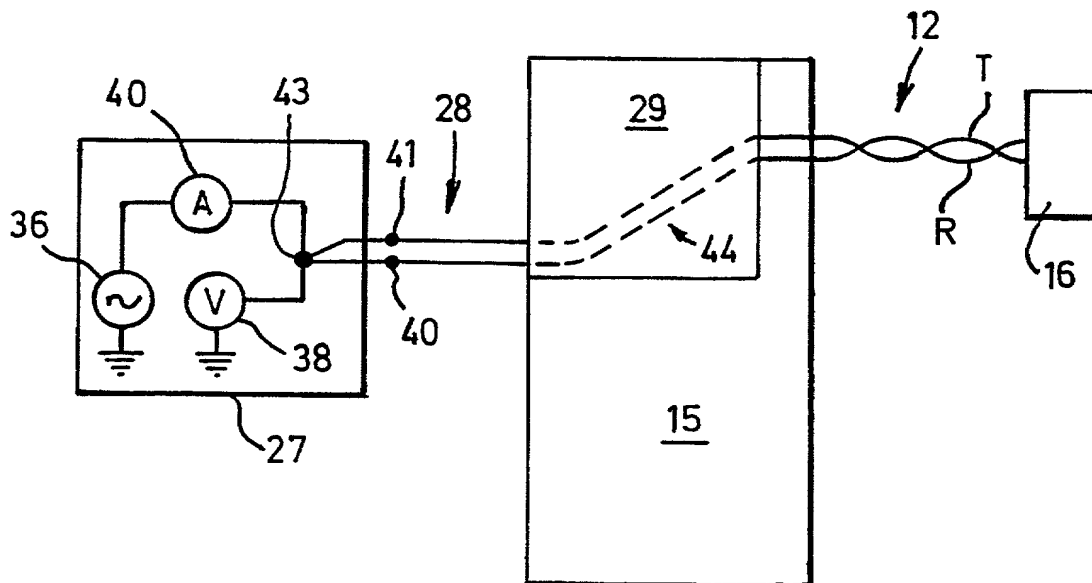


Fig.4.

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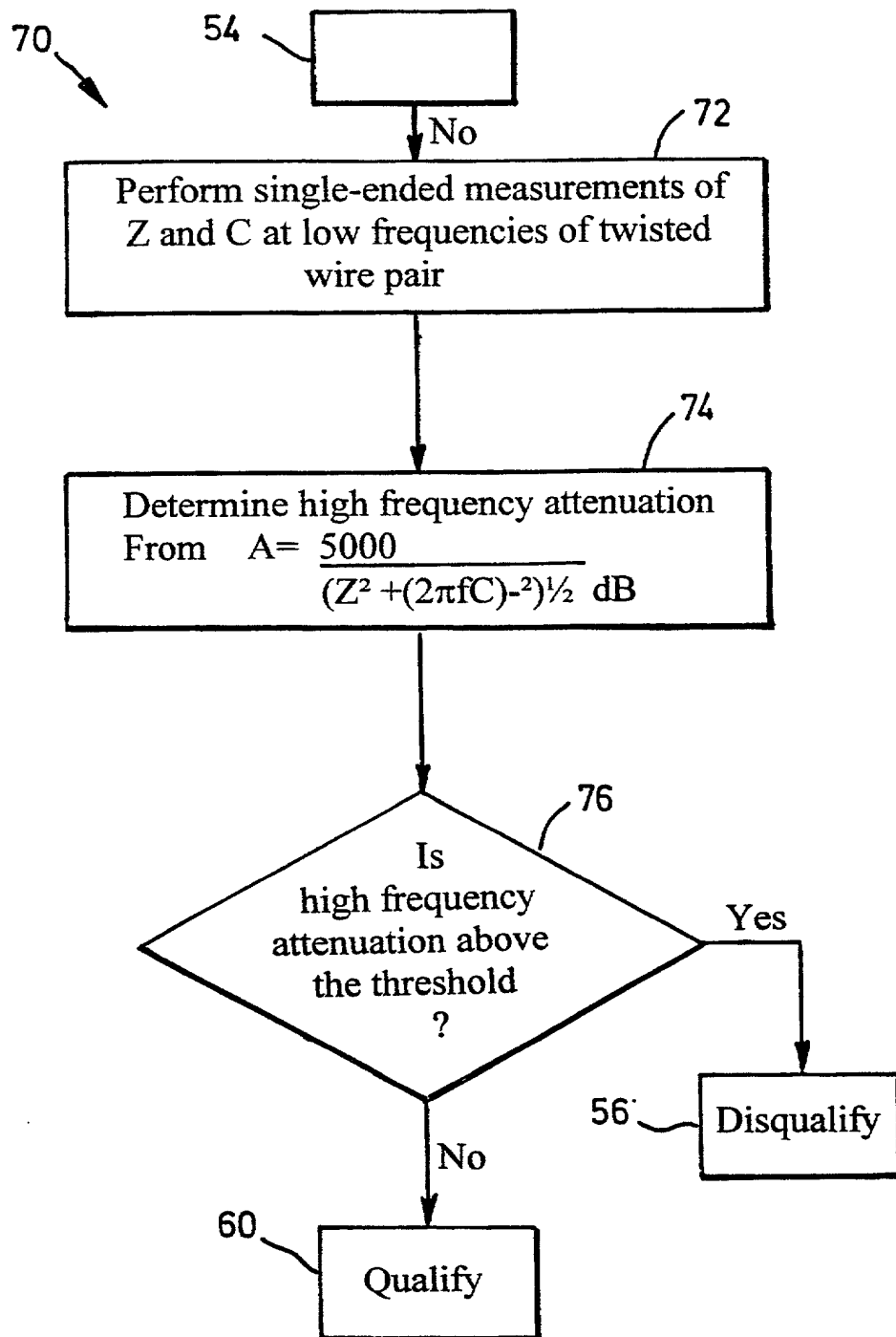


Fig.5.

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Segment 1	Segment 2	Measure +formula	Reference values
2km .6Cu		12 .39dB	12 .4dB
2km .6Cu	2km .6Cu	24 .17dB	12 .8dB
2km .6Cu	2km .5Cu	25 .59dB	27 .4dB
2km .5Cu		14 .26dB	15dB
2km .5Cu	2km .5Cu	29 .13dB	30dB
2km .6Cu	500m .5Cu	16 .74dB	15 .65dB
500m .5Cu	2km .6Cu	15 .92dB	15 .65dB
500m .5Cu	4km .6Cu	27 .04dB	28 .05dB
500m .5Cu	6km .6Cu	40 .30dB	40 .45dB

↑
1

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Fig.6.

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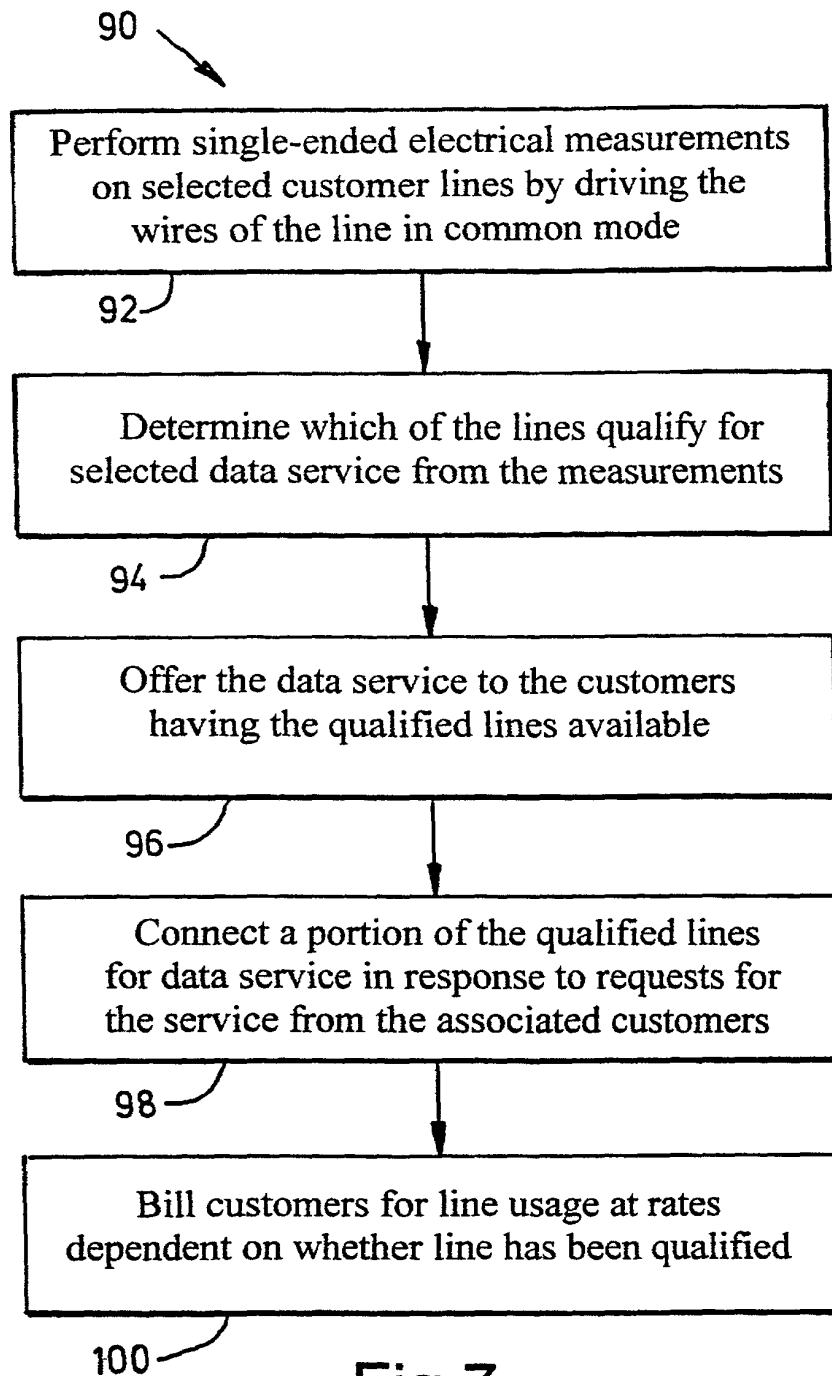


Fig.7.

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**DECLARATION FOR UTILITY OR
DESIGN
PATENT APPLICATION
(37 CFR 1.63)**

☒ Declaration Submitted with Initial Filing OR ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	1290-US
First Named Inventor	FAULKNER, Roger
COMPLETE IF KNOWN	
Application Number	/
Filing Date	
Art Unit	
Examiner Name	

As the below named inventor, I hereby declare that:

My residence, mailing address, and citizenship are as stated below next to my name.

I believe I am the original and first inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

QUALIFYING TELEPHONE LINES FOR DATA TRANSMISSION

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 06/23/2000 as United States Application Number or PCT International

Application Number GB00/02492 and was amended on (MM/DD/YYYY) 09/19/2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
				YES	NO
9914702.7	GB	06/23/1999	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

[Page 1 of 2]

DECLARATION — Utility or Design Patent Application

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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NAME OF SECOND INVENTOR: ☐ A petition has been filed for this unsigned inventor

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Family Name or Surname

Inventor's Signature

Date

Residence: City

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Country

Citizenship

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City

State

ZIP

Country

☐ Additional inventors are being named on the _____ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.